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Devise a trading strategy with ESG principles

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Abstract

This study analyzes the effect on performance when incorporating ESG principles into the 130/30 active extension investment strategy. By setting exposure to 130% for the long position of high-ESG-ranking stocks, and a 30% exposure for the short position of low-ESG-ranking stocks, positive and statistically significant abnormal returns of up to 8.532% can be achieved. However, the short position of this strategy generated a negative performance contribution, and the 130/30 strategy is not a statistically significant improvement to the long-only strategy. Nevertheless, it is still possible to slightly improve the information ratio when changing the long-short exposure and cut-off points.

Key words: ESG, Financial Performance, Trading strategy, Active extension strategy, Portfolio management; 130/30 strategy

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1. Introduction

Looking after the environment, plus issues of equality, ethnicity and governmental responsibility, have become hot topics in this day and age, gaining increasing importance and interest. In the finance industry, ESG standards have begun to influence investing activities that are interested in social, and financial value. These indicators are used to assess business practice sustainability from an environmental, societal, and corporate governmental perspective. Nowadays, more and more investors are taking ESG criteria into account in investment decisions, alongside financial performance, in order to mitigate risks, whilst also creating long-term value. To this date, previous studies have not given a consistent conclusion about the relationship between ESG scores and stock performance.

Several studies have enforced a long-only strategy, and a long-short market-neutral strategy, based on the screening approach (Kempf and Osthoff 2007; Derwall et al. 2005; Dorfleitner, Utz, and Wimmer 2013), to evaluate the abnormal returns of responsible investing. Such studies have shown notable results in terms of financial performance linked to ESG factor exposure. Yet, Derwall, Koedijk, and Ter Horst (2011) and Halbritter and Dorfleitner (2015), suggest that ESG investing will not be profitable in the long run. In the meantime, ESG concerned investors generally exclude low ESG performing stocks and "sin" stocks, restricting both available investment options, and realized returns, while leading to information loss. All things considered, this study aims to find an alternative investment strategy to boost ESG performance by including this underutilized information.

The argument is that the 130/30 strategy - a typical active-extension strategy - may be an effective approach to improve current ESG issues. It serves as an alternative to long-only funds by considering excluded companies in the short position as a possible way to enhance alpha. Simultaneously, increased long-side exposure, enables high ESG ranked companies to further

boost alpha and mitigate the risk of stock shorting. By doing so, information efficiency may be improved, whilst remaining market exposure is unchanged.

The 130/30 strategy is one of the fastest-growing strategies within the hedge fund industry. Suppose a portfolio manager invests $100 in the stock market, then shorts $30 of unattractive stocks. Then, gains from that short sale are used to purchase an additional $30 in those attractive stocks. With these operations, the manager ends up with 130% long exposure and a 30% short exposure, with a net market exposure of 100%, which is equal to the $100 actually invested.

This strategy has been successfully applied in the stock market but is relatively unexplored in ESG investigation. This thesis performs empirical analysis on this research gap. It investigates the implementation of a 130/30 active-extension strategy with ESG principles. A long-only portfolio and 130/30 portfolios was constructed based on overall ESG scores through negative screening. Then, each individual dimension E, S, and G, were screened in a robustness test. Based on the findings of this project, it is apparent that, although all 130/30 portfolios outperform the benchmark, the short position of bottom rated stocks has a negative effect on performance. This could yield a significant yearly abnormal return of up to 8.532%. Yet, the 130/30 strategy is not a statistically significant improvement to the long-only strategy. Nevertheless, it is still possible to slightly improve the information ratio when changing the long-short exposure and cut-offs.

2. Literature Review

2.1 Responsible Investing

Over the past decade, comprehensive literature and specialists on responsible investing, have emphasized the incorporation of the ESG approach into investment decisions in order to minimize the portfolio downside risks, (Kumar et al. 2016; Berg and Lange 2020) while seeking abnormal returns. This viewpoint is supported by the “doing well while doing well” hypothesis (Statman and Glushkov 2009), in which companies with higher ESG ratings are

predicted to achieve greater financial performance than their peers. In accordance with this hypothesis, Kempf and Osthoff (2007) established an abnormal return of up to 8.7% per year by implementing a long-short investment strategy on a portfolio with high ESG metrics and selling stocks in a lower rank on the U.S. portfolio, from 1992 to 2004. Furthermore, the studies show that responsible portfolios are tilted towards higher ESG rated stocks, as well as approximating the three socially responsible dimensions, which are: community, employee relations and environment. Statman (2009) reinforced Kempf ´s (2007) findings. Empirically, another explanation that could evaluate this phenomenon is that the stock market does not sufficiently recognize the value effects of ESG. Thus, investment in these businesses may also offer investors unexpected surprises (Derwall, Koedijk, and Ter Horsk 2011; Halbritter and Dorfleitner 2015).

Whilst there is evidence that companies with good ESG qualities can be financially rewarding, the limitation of selection requirements and the cost of narrowing down such industries via negative screening, may contribute to a lack of portfolio diversification. Several empirical studies have indicated that there is no statistically significant evidence that SRI generates abnormal returns - most of them clarified this phenomenon by financial behaviour. In line with this argument, Derwall, Koedijk, and Ter Horsk (2011) discussed the "shunned-stock" hypothesis. He argued that value-driven investors remove low-ESG rated companies, as well as controversial companies, to meet their ethical standards. However, this “shortage of demand” for irresponsible stocks may lead them to become underpriced. Furthermore, the smaller investor base means a large risk-sharing opportunity in the market for shunned stocks, leading to a return premium (Merton 1987; Heinkel, Kraus, and Zechner 2001). Consistent with this finding, Hong and Kacperczyk (2009) especially, claimed that these, so-called, "sin" stocks capture this premium in their risk adjusted return. With this in mind, Statman and Glushkov

(2009), further observed that, even though stocks with high SRI ratings outperformed low rating stocks, their benefit is partially offset by the drawback of removing shunned companies.

2.2. Active extension strategy

Active extension strategies are a benchmark-relative strategy aimed to increase exposure to the alpha model in order to outperform a benchmark by relaxing the long-only constraint, whilst, having a similar net market exposure as a long-only fund. The emergence of active extension strategies has been derived from the intrinsic drawbacks of a long-only strategy - low capability to either over weigh the attractive stocks, or under weigh the unattractive ones. This argument is well documented as the loss of efficiency of the long-only constraint by Jacobs, Levy, and Starer (1998). Grinold and Kahn (2000) and Clarke, Harindra, and Steven (2004), both stand by this argument, showing that removing this constraint can lead to a substantial improvement in information efficiency, as measured by the information ratio (IR). Furthermore, Johnson, Ericson, and Srimurthy (2007) suggested an approach to performance attribution. The conclusion drawn was that this improvement was due to a rise in alpha levels without adding much incremental risk.

When comparing with the long-short strategy, the active extension strategy has the advantage of 100% net market exposure. This is more comparable with a long-only strategy and can be measured using the same benchmark (Waid 2009; Jacobs and Levy 2007). Therefore, the active extension strategy can be measured by relative return and risk-adjusted performance, rather than absolute return, limiting unexpected risk occurring when following a normal long-short strategy. Nevertheless, there are two main drawbacks: leverage risk – unlimited losses on the short position (Jacobs and Levy 2006; Brush 1997) and high expenses – leverage costs, transaction costs and management fees (Sorensen, Hua, and Qian 2007).

2.3 Active extension strategies in ESG

Investors aligned with ESG investing criteria often avoid holding “sin” stocks and stocks with a poor ESG ranking. By using the active extension strategy, a portfolio can still avoid having a long position in poorly ranked ESG firms, while allowing the shorting of those screened stocks to finance the long position to overweight top-ranked stocks. It may help performance and mitigate shorting risk. By doing so, the shorting position is crucial for implementing the 130/30 strategy into ESG investing. However, low ESG scoring shorted stocks are currently a controversial topic in both responsible investing and the stock market (Strauss, Pekin, and Strauss 2017; Jacobs and Levy 2006; Clarke, Harindra, and Steven 2004; Gastineau 2008). The article of Citywire (2019), widely discussed the predicament of shorting poor ESG companies based on an ethical perspective. Conversely, Strauss, Pekin, and Strauss (2017) argued that allowing the shorting of poorly ranked ESG companies would help performance, whilst also showing a wider expression of an investor´s views on management. In other words, the shorting of these stocks could be seen as a sign from investors that the public is not satisfied with these firms’ approach to ESG responsibility. This presents an interesting picture, where the value of stocks may not only be perceived based on financial metrics, but also by societal and ethical values. Unexpectedly, the Strauss, Pekin, and Strauss (2017)’s result showed a negative performance contribution due to “stock price momentum and spiking borrowing costs”. Therefore, when selecting stocks for a short position for the 130/30 ESG investing strategy, risk management and adequate management of turnovers are crucial.

To date, whilst several researchers have explored the effect on financial performance when implementing active extension strategies in the equity market, few studies have investigated this strategy with ESG factors. Among them, Filbeck, Holzhauer, and Zhao (2014), especially, studied the 130/30 active extension in responsible investing for the entire U.S. market, which is comprised by the Domini 400 Social Index and the S&P 500. They designed three long-only portfolios and three 130/30 portfolios by comparing the information ratio and abnormal returns.

The results show that all portfolios generated statistically significant abnormal returns, where 130/30 portfolios outperformed the long-only portfolios, generating a higher information ratio. Another finding of this research suggests that employing 130/30 strategies that include stocks from both high-ranking score companies, and shunned ones, may generate alpha.

This thesis primarily takes inspiration from the previous literature of Kempf and Osthoff (2007), Filbeck, Holzhauer, and Zhao (2014) and Johnson, Ericson, and Srimurthy (2007) and is dedicated to large firms within the S&P 500 index. Contrary to Filbeck, Holzhauer, and Zhao's (2014) study, in this study, a negative screening on overall ESG score includes shunned stocks in the short position, as well as individual pillar E, S and G screenings. Taking note from their research, an empirical analysis, namely the mean alpha difference test, is used to confirm whether the outperformance, or underperformance, is statistically significant or not.

My study provides a view for portfolio managers, from an empirical perspective, on developing an active extension strategy on the ESG investing. The purpose of this study is to find a trade-off between the conventional, long-only strategy and the long-short strategy, whilst maintaining positive returns and mitigated risk.

Taking into account that an inverse relationship is expected between top ESG firms in the long position, and bottom rating firms in the short position. Over the long-term, three hypotheses have been formulated. 1) All of the 130/30 portfolios will statistically outperform the benchmark. This hypothesis is to test whether ESG investing will generate a higher return by implementing an active extension strategy. 2) All 130/30 portfolios will show a statistically significant improvement when compared to the portfolio with the long-only strategy. This hypothesis is committed to investigate the potential benefits of relaxing the long-only constraint. 3) Whether the short position adds value or loss. This hypothesis is intended to study the performance contribution by trading screened companies.

3. Data

3.1 ESG metric

The ESG is a multidimensional notion (Galema, Plantinga, and Scholtens 2008) that stands for environmental, governmental, and social, and its rating can be viewed as a collection of metrics for measuring the extra-financial ESG performance. ACCF (2018) is dedicated to the study of ESG ratings and revealed some primary issues related to ESG scores. They noted that, since ESG data providers use a wide variety of methodologies and techniques to quantify ESG scores, "one company can carry divergent scores and rankings from different providers simultaneously" (ACCF 2018). Therefore, lack of a common rating method and inconsistency between ESG rating providers, (Chatterji et al. 2016; Halbritter and Dorfleitner 2015; Dorfleitner, Halbritter, and Nguyen 2015) could confuse the ratings. Meanwhile, investors must ensure that the rating method is aligned with their specific ESG preferences. In addition, ESG ratings have presented strong evidence of a systematic correlation with the size, geographic and industry of a firm (Kotsantonis and Serafeim 2019; Drempetic, Klein, and Zwergel 2020). Such characteristics have been proven as the cross-sectional determinants of stock return which constitutes a potential bias.

3.2 Data sample

The primary data source of this thesis is an ESG database provided by MSCI (KLD), and financial performance measures from Bloomberg. The MSCI ESG ratings is the broadest existing dataset on ESG matters and is widely used in academic research (Kempf and Osthoff 2007; Galema, Plantinga, and Scholtens 2008; Mănescu 2011). The MSCI ESG scores are the combined performance of seven components, which are summarized into the following three dimensions: First, E represents Environment. Second, S is Social, which is then broken down into five sub-dimensions, being: Community, Diversity, Employee Relations, Human Rights, and Products. Finally, G stands for Governance. The aggregated scores are derived from a subset of more than 80 indicators, which are annually measured by strengths and concerns

based on a binary scoring model, i.e., giving score of "1" if a strength or concern is present, otherwise "0".

This thesis followed the method of Kempf and Osthoff (2007) to compute company´s ESG score, converting all concerns into strengths, by taking the opposite binary value. The overall strengths for each of the dimensions were summed up and normalized between 0 and 1. For the final ESG score, each dimension was given an equal weight. Apart from these seven themes, the MSCI has exclusionary screens for alcohol, gambling, firearms, military, nuclear power and tobacco. Given the nature of these screens, I define all companies with the presence of these metrics as "shunned stocks." The financial dataset is taken from in the U.S. market, comprised of all companies from the S&P 500, from 1991, to 2016, on a monthly basis. According to Waid (2009) "the long-only benchmark is the natural choice to measure the active extension manager skill." The S&P500 was selected for the benchmark of this study, as it is the most commonly used U.S. benchmark index.

In order to match MSCI ESG data with financial data, each firms CUSIPs code, ticker, name and year were used to identify firms that were in both the S&P 500 list, and the MSCI database, while eliminating firms without return records in the S&P 500 index in the corresponding year. The study yields 465 firms fulfilled this condition aggregated into eleven sectors, with 7,586 company-year observations for a **full sample** from 1991 to 2016. Among the 465 companies, 132 are **shunned stocks**, consisting of 1,337 observations. The remaining 6,249 observations are defined as **non-controversial stocks,** which is made up of 420 companies (Exhibit 1)

Exhibit 1- Summary statistic of the sample portfolio for overall ESG score

Overall ESG score	Firms	N	Mean	SD	Kurtosis	Skewness	Min	Max
Full sample	465	7586	0.464	0.095	0.301	-0.184	0.125	0.846
Shunned sample	132	1337	0.449	0.100	0.029	0.201	0.190	0.835
Non-controversial sample	420	6249	0.468	0.093	0.438	-0.271	0.125	0.846

The discrepancy between accepted samples and controversial samples is that, during the 26-year timeline, some companies are considered as shunned stocks during specific periods and are viewed as non-controversial for others.

ESG is comprised of three individual dimensions; E, S and G. Exhibit 2 shows that the trend of all scores have increased over the past 26 years, with the exception of the significant

downturn in 2010 due to the varying total number of metrics and improvements in the ranking methodology in 2010. Exhibit 3 revealed the distribution for the total ESG score and three dimensions. The database composition is mostly clustered in a range of scores between 0.2 and 0.7.

Exhibit 2: ESG score evolution.

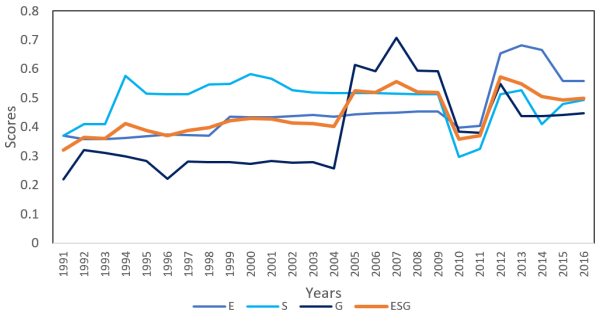


Exhibit 3: Distribution of ESG scores of firms

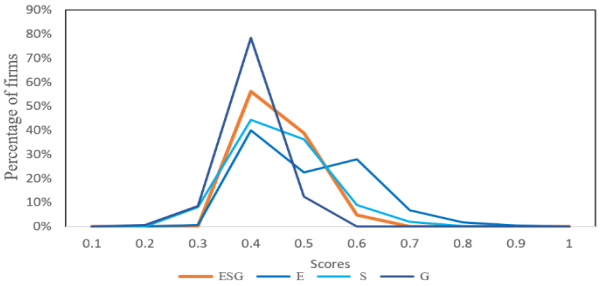


Table 1 (Appendix) provides data to illustrate the main ESG bias. Firstly, as the sample consists of large U.S. companies, the size bias is not concerning in this case. It can be seen in Table 1.1 (Appendix), which shows the regression of firm's ESG scores on the log of market capitalization. Although the sample showed significantly positive results, the loading is low (0.018) with an R^2 of only 0.086. Its relation is also relatively low in this study. The same can be said for criteria E and S. However, G, demonstrated a negative correlation with firm size (-0.008), but with an R^2 of 0.015. Secondly, the best-in-class (industry adjusted) method, was the primary approach taken by previous research Filbeck, Holzhauer, and Zhao (2014) to eliminate the industry bias, which is especially useful when having a large data set. However, the database of this study is relatively small, and some industry, the energy and the real estate, are underrepresented in the S&P 500, especially in the early period, which can be seen in Table 1.2 (Appendix). Hence, this approach is not used here. Finally, the sample represents a wide variety of industries, and the mean ESG scores of each industry are similar, all around 0.45.

3.3 Portfolio formulation

All samples and portfolios are constructed at the beginning of each year *t,* based on an MSCI score, which was reported at the end of each year t-1, by MSCI, with 1 year holding period and

rebalancing at the end of every year. There is a time series of monthly returns from the period of January 1992, to December 2017. For each month, the S&P 500 is used as a benchmark, and the selected stocks within the universe are used to construct the portfolios. The portfolios are on an equally weighted basis, which has the benefit of being simple, transparent and reducing single-stock concentration. As a result, it is more comparable across industries and firm sizes.

This section begins by creating yearly rebalanced decile portfolios with the data from the non-controversial sample, by sorting stocks based on their overall ESG score over 26 years, and matching rating deciles with stock returns. For negative screening (Table 2.1- Appendix), high overall ESG rating does not systematically reflect higher returns. Notably, the worst decile 10, showed the lowest return and Sharpe ratio, due to the higher risk, which aligns with our purpose of excluding the stocks with the worst ESG performance. For individual dimension score screening (Table 2.2A - Appendix), only the E score-based rating showed a similar pattern with the overall ESG score-based rating. However, all top sample portfolios have a higher Sharpe ratio than the bottom sample ones, due to a lower standard deviation. Based on these findings, it is safe to conclude that the higher performing ESG stocks did not systematically outperform the lower scoring ones. Instead, what can be confirmed, is that they have a lower level of risk. Furthermore, cross-sectional correlations between the ranking of the three dimensions were observed to be low, varying from 0.080 to 0.240 (Table 2.2B - Appendix). Unfortunately, this approach still possesses a bit of an industry bias, with Table 2.3 (Appendix) indicating the concentration in the worst-decile in the energy sector, and the best-decile in the finance one.

Based on this information, 4 groups of top and bottom sample portfolios are drawn based on 4 screening policies. The first is a **negative screen** applied to the overall ESG score, which combines the scores of the 3 dimensions. Under this policy, with the exception of the shunned sample, the non-controversial sample is further divided into 2 sub-sample portfolios. The top sample is defined as the top 3 deciles, due to similar levels of return and risk. The bottom

sample is the worst decile (10%). The remaining three **individual dimensional screens** followed a similar pattern, where the bottom sample is comprised of 10% of the worst scoring stocks. All remaining stocks are included in the top sample of each screen.

3.4 Methodology

This thesis compares the financial performance of an active extension strategy to that of a benchmark and long-only strategy by considering long-term, relative return performance. Henceforth, the active extension strategy is explicitly referred to as the 130/30 strategy, which places the long and short position leverage level, to 130% and 30%, respectively. Following this procedure, 10 strategy portfolios with a long-only, and a 130/30 strategy, are formulated based on 4 screenings:

1) Four **long top-only** portfolios for each of the 4 screenings: 100% exposure in the long position for the top sample of each screening.
2) Four **130/30, top-bottom, (130/30 TB)** portfolios for each of the 4 screenings: 130% exposure in the long position for the top sample, and 30% exposure in the short position for the bottom sample of each screening.
3) One **130/30, top-shunned, (130/30 TS)** portfolio for the negative screening: 130% exposure in the long position for the top sample, and 30% exposure in the short position for the shunned sample.
4) One **130/30, top-bottom-shunned, (130/30 TBS)** portfolio for negative screening: 130% exposure in the long position for the top sample, and 30% exposure in the short position for the bottom and controversial samples.

The structure of the performance analysis is primarily segregated into several stages. The analysis process started by studying the return performance of portfolios for both the 130/30 and long-only strategies for the aggregated ESG score portfolio, which is dedicated to study hypothesis 1. Secondly, a variety of return and risk-adjusted performance analysis, especially

focusing on the information ratio (IR), which can directly answer hypothesis 2. Thirdly, the significant difference in the portfolio's Jensen´s alpha is tested in order to further verify the crystallization taken from the IR. Fourthly, to determine whether the short positions of the 130/30 portfolios add value or loss, this study addresses the third hypothesis. In the case of losses, it is investigated whether the benefits from the long position can bear the losses from the short one in the 130/30 portfolios. Finally, multi-factor models were employed, to assure the validity of performance. In addition, the robustness test is proceeded by several criteria to assess the sensitivity of results. Firstly, the top portfolio cut-off point of overall ESG is increased to capture the flexibility and diversification in the long portion. Secondly, the entire performance analysis process is repeated for each individual E, S and G screening. In terms of the 130/30 strategy, scenario analysis 110/10, 120/20, 130/30, 140/40 and 150/50, are tested to find the best proportion of active exposure based on risk and return.

3.5 Performance measurement

1) The Sharpe Ratio (SR) (Sharpe 1966,1994) is defined as the excess return of the portfolio divided by the volatility measured via the standard deviation. The higher the Sharpe ratio, the better the combination of risk and return, which represents the incremental risk-adjusted return per unit of incremental risk.

$$SR = \frac{E(R_p - R_f)}{\sigma} \quad (1)$$

Where r_p denotes the portfolio return, r_f represents the risk-free return, and σ represents the standard deviation of the monthly excess return.

2) Skewness is the degree of distortion from the normal distribution that measures the lack of symmetry in data distribution. **Kurtosis**, on the other hand, measures the weight of returns in the tails of the distribution. Whenever the skewness is near 0, and kurtosis near 3, the **Bera-Jarque test** is used to test for normality.

3) The Adjusted Sharpe Ratio (ASR) (Pézier and White 2008), overcomes the deficiency of the Sharpe Ratio - which only works under the assumption of normally distributed returns, by incorporating a penalty factor for negative skewness and excess kurtosis.

$$ASR_p = SR_p \left[1 + \left(\frac{Skew}{6}\right) SR_p - \left(\frac{Kur}{24}\right) SR_p^2\right] \quad (2)$$

4) The Treynor ratio (TR) (Treynor, 1966) is similar to the Sharpe ratio. The difference, however, is that it measures the return per unit of systematic risk, as calculated by beta, instead of total risk. However, this measurement is less frequently used for performance analysis as it ignores specific risk.

$$TR = \frac{E(R_p - R_f)}{\beta_p} \quad (3)$$

Where systematic risk β_p is the regression of the monthly excess returns for the portfolio against market excess returns.

5) The Information Ratio is active returns, divided by its tracking error. The numerator is the excess return of the portfolio compared to the selected benchmark (S&P 500). The denominator is the standard deviation of this excess return. The information ratio is the incremental risk-adjusted active return per unit of incremental active risk. It is one of the key metrics used to measure the skill of an active portfolio manager.

$$Information\ ratio = \frac{R_p - R_B}{\sigma} \quad (4)$$

Where R_B denotes the return of benchmark.

6) The Alpha - Jensen´s alpha (Jensen 1968) is used as a measurement of portfolio abnormal returns, which is the intercept of the regression equation in the CAPM for excess portfolio returns portfolio, against excess returns adjusted for systematic risk.

$$\alpha_p = R_{pt} - R_{ft} + \beta_p(R_{mt} - R_{ft}) \quad (5)$$

7) The Long and short Contribution is used to identify whether the long and short positions generate value or produce a loss, in comparison with the benchmark. The formula calculation

is inspired by (Johnson, Ericson, and Srimurthy 2007). The contribution of portfolio excess returns from the long portion, C_{Lpt}, is as follows:

$$C_{Lpt} = (R_{Lpt}\text{-}R_{Bt}) \times W_{Lp} \quad (8)$$

The contribution of portfolio excess returns from the short portion, C_{Lpt}, is as follows:

$$C_{Spt} = (R_{Spt}\text{-}R_{Bt}) \times W_{Sp} \quad (9)$$

Where R_{Lpt}, R_{Spt} and R_{Bt} stand for the returns from the long portion, the short portion of the portfolio, and the benchmark at time t, respectively. W_{Lp} and W_{Sp} denote the long and short exposure position of the portfolio, which is 1.3 (130%), and 0.3 (30%), respectively.

8) The Fama-French (1992) three-factor model evaluates the abnormal returns of the long-only and 130/30 portfolios by considering market return, size, and value factors (equation 6). **Carhart´s (1997) four-factor model**, inspired by (Jegadeesh and Titman 1993) one-year momentum anomaly, is obtained by adding the momentum factor to the three-factor model.

$$R_{pt} - R_{ft} = \alpha_p + \beta_{1p}(R_{mt} - R_{ft}) + \beta_{2p}SMB_t + \beta_{3p}HML_t + e_{pt} \quad (6)$$

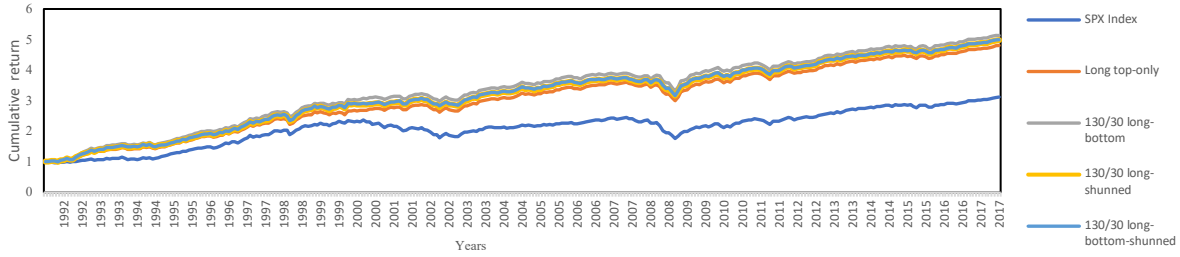
$$R_{pt} - R_{ft} = \alpha_p + \beta_{1p}(R_{mt} - R_{ft}) + \beta_{2p}SMB_t + \beta_{3p}HML_t + \beta_{4p}MOM_t + e_{pt} \quad (7)$$

The dependent variable is the monthly excess return of portfolio *p,* for month *t,* over the risk-free rate. The independent variables are the returns of three factor portfolios. $R_{mt} - R_{ft}$ is the excess return of the market portfolio. SMB_t is the size factor, HML_t is the factor, and MOM_t is the momentum factor.

4. Empirical Result

4.1 Return performance

Exhibit 4: Cumulative Returns (1992 to 2017)



As can be observed in Exhibit 4, both long-top only, and 130/30 portfolios, outperform the benchmark S&P 500 over the 26-year test period. Furthermore, all 130/30 portfolios slightly outperform the respective long top-only portfolio. These results provide evidence of a possible investment return enhancement by allowing a reasonable amount of shorting, and a long-only constraint extension. In more detail, Table 3 (Appendix) summarizes the return and risk-adjusted performance of portfolios for the aggregated ESG score. As reported in Table 3A (Appendix), the 130/30 top-bottom and 130/30 top-bottom-shunned portfolios provide the highest annualized basis returns, of 15.782% and 15.161%, respectively, when compared with the benchmark, which has 7.407%. As mentioned in the literature review, the portfolio´s performance of both strategies should be evaluated against the benchmark, rather than absolute returns. Hence, relative performance is used. The result indicates that all portfolios from both strategies generate statistically positive returns when confronting the benchmark. However, the same cannot be stated when comparing the relative returns of the 130/30 portfolios with its counterpart – the long top-only portfolio. While the 130/30 portfolios produce an annualized relative return of approximately 8% - roughly 1% higher than the returns of the long top-only strategy, this difference is not statistically different.

4.2 Risk-adjusted performance and Alpha comparison

(Table 3B – Appendix) In terms of risk-adjusted measurements, the Sharpe ratio and Treynor ratio generated by long top-only, and 130/30 portfolios, were larger than the benchmark around 2 times in ratio. However, consistent with the result of the Benchmark, both strategies showed negative skewedness and positive excess kurtosis. As for the result of the Jarque-Bera test, the normality assumption was rejected. Therefore, the Adjusted Sharpe Ratio is used. Although the ASR is lower than the Sharpe Ratio, it is still much higher than the benchmark´s. When evaluated on relative risk-adjusted performance, the information ratio for both strategies is

positive against the benchmark. Unfortunately, the 130/30 strategy underperforms the long top-only strategy, as seen in Exhibit 5 and Exhibit 6. The information ratio of all 130/30 portfolios is slightly lower than the long top-only portfolio. This is likely due to the fact that the proportionate increase in risk for the 130/30 strategy, when compared to the long-only strategy, is higher than the increase of active returns. The risk is measured by tracking errors, that increased by around 16% on the 130/30 portfolios, by taking the short position and relaxing the long-only constraint. This circumstance shows that relaxing the long-only constraint's yield to a higher return is associated with substantial added risk.

Exhibit 5: Comparison of information ratio (IR).

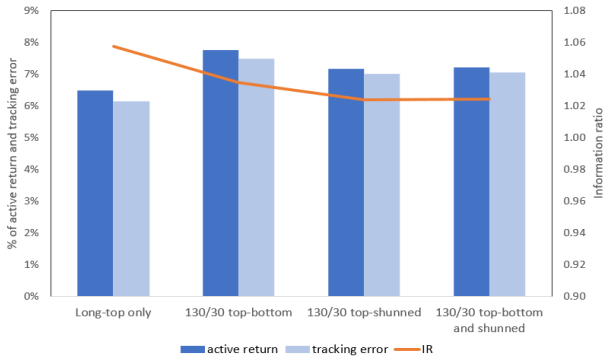


Exhibit 6: Information ratio and alpha model

	Information Ratio			Jensen´s Alpha	
	Active return	Tracking Error	IR	Alpha	t - dif
Long only					
Long-top only	0.541%	1.771%	0.31	0.561%***	
130/30					
130/30 TB	0.645%	2.161%	0.3	0.660%***	-
	1,19x	*1,20x*	*0,98x*		
130/30 TS	0.597%	2.020%	0.3	0.607%***	-
	1,10x	*1,14x*	*0,97x*		
130/30 TBS	0.601%	2.033%	0.3	0.613%***	-
	1,11x	*1,15x*	*0,97x*		

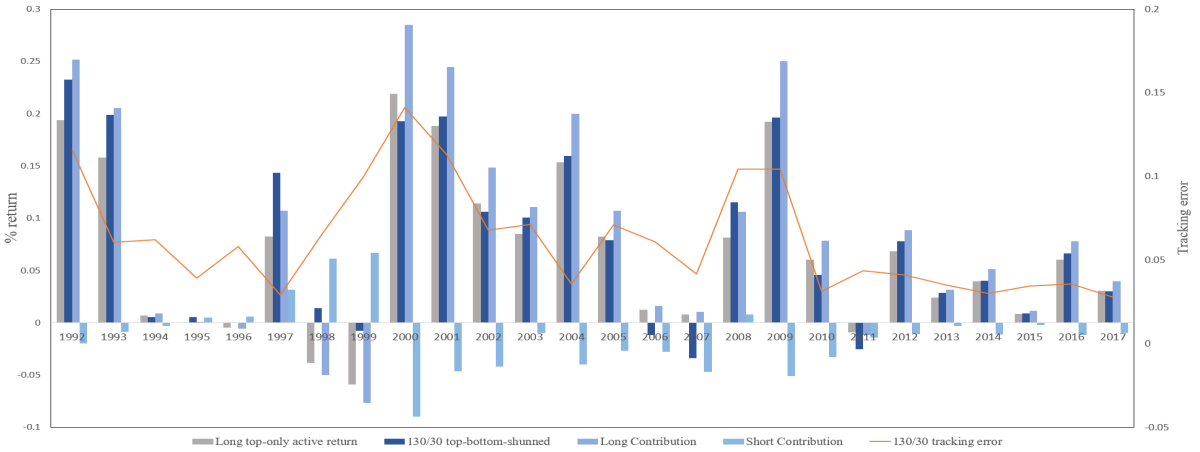
* , **, and **** indicate statistical significance at the 10%, 5% and 1% levels.
"-" indicates no statistically significant difference.

Regarding Jensen´s alpha result Exhibit 6, there is a strong evidence that both strategies outperformed the benchmark on a monthly alpha basis. However, the difference of monthly alpha generated between the 130/30 portfolios and the long top-only portfolio is not statistically significant. For instance, the p-value was used in the t-test for the difference of the 130/30 top-bottom portfolio monthly alpha results of 0.660%, and the long top-only portfolio result, of 0.561%, is 0.53 which is significantly higher than 0.05 of the significance level. This result fortifies the information ratio and cumulative relative return comparisons. Hence, these three findings show that there is no statistically significant improvement in alpha by relaxing long-only constraints in the ESG investing.

4.3 Performance contributions

In this segment, relative performance is broken down into three contributions, the long position, the short position, and the long-short interaction, respectively. Considering all three 130/30 portfolios showed similar results, focus will be placed on the 130/30 top-bottom-shunned portfolio (130/30 TBS) in order to proceed with further analysis in the following sections of this dissertation. Equations 8 and 9 are applied on the annualized compounded returns mentioned in the beginning of this chapter. Overall, during the time period in analysis, 130/30 strategy returns had a compounded annualized average of 15.161% over the entire 26-year period, outperforming the S&P 500 by 7.754%. The positive contribution of the portfolio´s long portion has solely achieved this performance gain. It can be verified in Table 4 (Appendix), that the long position of the portfolio exceeded the benchmark. Thus, it contributed 9.142% to the portfolio's overall excess return. Conversely, the short side generated a positive return that surpassed benchmark returns by 4.310%, leading to a negative contribution of 1.293%, with 30% exposure. This reduced the overall portfolio from 9.142% to 7.849%

Exhibit 7: Annual compounded relative returns of 130/30 TBS and long top-only portfolio



In the perspective of annual performance, the long position resulted in a positive contribution for 22 years. For the short position, out of 26 years, only 6 were positive ones (Table 4 – Appendix). Exhibit 7 demonstrates that, for most of the years, the short positions of the 130/30 portfolios produce a negative value. In this instance, 3 years of these losses cannot be compensated by the long side of the portfolio. These findings point to the conclusion that the

short position, far from benefiting the performance, is diminishing it. Even so, this perspective ignores several short position advantages. Apart from the benefit of a beta close to 1 and a 100% portfolio exposure, the short position does not only enable the portfolio to diversify the stock selection, but also the portfolio becomes more versatile in taking more active risks on long positions.

Although the increase of flexibility leads to the potential to add value from a long position, Table 5 (Appendix) shows that 130/30 strategies underperformed the long-only strategy in 9 out of the 26 years, the result remains low. This is due to the poor contribution from the short position, and the 130/30´s overall return is not significantly different from the long top-only portfolio.

This thesis argues that implementing the 130/30 strategy in ESG investing generates loss in the short position of low ESG performance and shunned stocks, and this loss cannot be efficiently managed to be compensated by the stocks with higher ESG rating. This inefficient alpha generation from the short portion, leads to no statistically significant difference, and achieves a lower information ratio than the long-only strategy,

4.4 Multifactor analysis

Table 6 (Appendix) demonstrates the performance measurements of the (Fama and French 1992) three-factor, and (Carhart 1997) four-factor regressions on the 4 portfolios from the long-only strategy and 130/30 strategy. All portfolios showed a significant outperformance at a significance level of 5%, 10% and 1%. The generally higher abnormal return is especially notable in 130/30 strategy portfolios. The 130/30 top-bottom portfolio generates the highest monthly alpha in three-factor and four-factor regressions compared to the long top-only portfolio. However, the alpha of the two strategies is not statistically significantly different.

This result assures the previous finding that there is no statistical improvement in the 130/30 strategy against long-only strategy.

Regarding the three-factor loadings, there are no notable differences between the beta of both strategies, and all portfolios exhibit significant positive factors. The output indicated that in the portfolio companies tend to be value companies and small size. This can be the effect of an equally weighted portfolio construction. The momentum factor is nearly zero, with no evidence of strong statistical significance. Moreover, at least 80% of the observed variations could be explained by the model´s input, as demonstrated by the high R^2.

5. Robustness test

5.1 Alternative cut-offs

Table 7A (Appendix) shows the performance comparison between 2 cut-offs of the top sample on overall ESG score. Cut-off of the top sample was increased from 30% of best ESG performance companies, to 90% of best-ranked companies within the non-controversial sample. This new top portfolio is defined as the long 90% top portfolio for the long top-only strategy, and 130/30 90% top-bottom-shunned portfolio (130/30 TBS) for the 130/30 strategy. The overall performance of the new cut-off is obviously improved. Under a new cut-off, the information ratio of the 130/30 portfolio sharply increased to a similar level as the long top-only portfolio, which is 0.401 and 0.395, respectively. However, the difference of return is not statistically significant. While comparing to the former cut-off of the 30% top portfolio, both the tracking error and active returns are significant improved. Therefore, increased stocks in the top sample take advantage of diversification, which leads to lower risk and increase returns.

5.2 Individual E, S and G screening

The same analysis process of the overall ESG score was applied to each individual E, S and G dimensions for both strategies. The portfolio formulation was explained in the 3. Data session. The performance measures for E, S and G based rankings are given in Table 7B (Appendix).

Overall, all portfolios of the three dimensions outperformed the benchmark by generating superior returns over the 26-year holding period. Among these dimensions, E ranked portfolios exhibit a performance pattern similar to the overall ESG portfolios. On the contrary, S and G ranked 130/30 portfolios, both generated slightly lower relative returns than their respective long top-only portfolio counterparty. G presented the worst performance compared to E and S, contributing the lowest returns and the highest tracking errors, which leads to a monthly information ratio of 0.170 for the 130/30 strategy. This finding illustrates the underperformance of the 130/30 strategy against the long top-only strategy in terms of individual dimension screening. This evidence is especially highlighted on social, and governance ranked approaches.

5.3 Alternative active weight

For both the overall ESG score, and the individual dimension ranking, a scenario analysis was constructed for alternative active extension portfolio by changing the long and short exposure to 110/10, 120/20, 140/40 and 150/50.

Exhibit 8: Active weight analysis

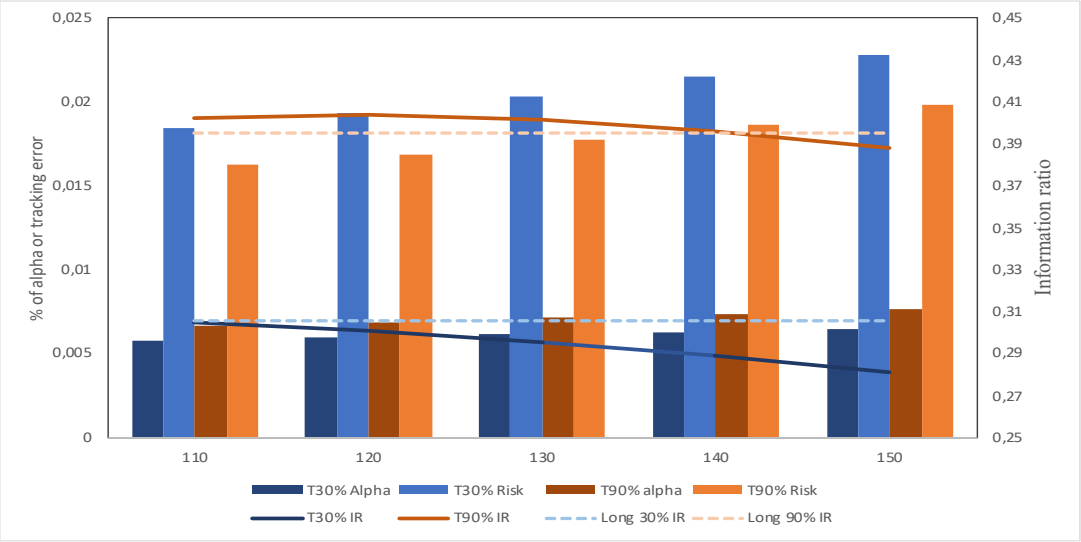


Exhibit 8 shows the monthly basis tracking error, alpha and information ratios graphs for the overall ESG portfolios. The best scenario for 30% top sample cut-off is 110% long exposure

and 10% short exposure, which generates a superior information ratio than the 130/30 portfolio but is still slightly lower than the long top-only portfolio. Notably, the 90% top sample provides much better performance than the top 30% sample amongst the 5 long-short weight scenarios. For 90% top sample cut-off, the 120/20 strategy delivered the best information ratio which is much higher than its long-only strategy counterpart. Unfortunately, the alpha difference is not statistically different. All E, S, and G individual dimensions-based portfolios demonstrated similar patterns, where the 110/10 strategy is the best scenario that provides the highest information ratio among other active extension strategies.

This finding illustrates that, the higher the active exposure on the long and short proportion, the better the performance of the portfolio in terms of returns. However, the risk increases as the alpha increases. Therefore, exploring the trade-off point between return and risk is crucial. Moreover, the different cut-offs are a vital variable in terms of the ability to bear the risk that comes with active exposure and generates higher abnormal returns.

6. Discussion

The present study was designed to evaluate a new active trading strategy for ESG investments with a view to ensuring the effectiveness of taking advantage of the shorting of those excluded stocks and examining the long side exposures. The idea behind this thesis was influenced by Filbeck, Holzhauer, and Zhao (2014), starting by the creation of multiple portfolios with an active 130/30 strategy and a long top-only strategy with ESG principles.

Based on the 26 years of analysis collected, a significant excess return is discovered on all 130/30 portfolios, relative to the standard portfolio, S&P 500. However, when comparing the relative return (against the benchmark) of the long top-only portfolio, in general, there is not a statistically significant difference. This result was further confirmed by analyzing risk-adjusted

performance, where all 130/30 portfolios have a lower information ratio than the long top-only portfolio, both in overall ESG score rankings, and individual dimensions-based rankings. Nonetheless, it is still possible to boost performance to generate a higher information ratio, for example, in the 120/20 or 110/10 strategy. The finding of this thesis contradicts Filbeck, Holzhauer, and Zhao's (2014) previous study, which shows that all of their active extension portfolios are built by overall SR ratings, have a higher information ratio than their respective long top-only portfolios, and highlights the outperformance of active extension portfolios against both long top-only portfolios, and the benchmark. However, some reservations remain about this conclusion. Elaborating on Filbeck, Holzhauer, and Zhao's study (2014), the significance test was further used to study the alpha comparison between both counterparty portfolios of the long top-only and the 130/30. The conclusion is that, whilst the 130/30 portfolios produced a higher alpha than the long top-only portfolio, it is not statistically significantly different. The research of Johnson, Ericson, and Srimurthy (2007) supports this result. He argued that, instead of a lower tracking error, higher alpha in the 130/30 strategy should be the reason for the improvement of the information ratio. This argument is especially confirmed when the scenario analysis was proceeded, by increasing the active weight from 110/10 to 150/50. The result highlight considering the trade-off of achieving higher return by active risk-taking. However, under the inefficiency alpha generation model, this work suggests that the improvement of the IR resulted from changing the active weight, and the cut-off point, as mentioned above, will not vary significantly.

The active performance contribution is also studied. The result is in accordance with Lo and Patel's (2008) 130/30 strategy study. It is noted that, although the 130/30 strategy delivered negative value-added in the short position, this short position may significantly boost the performance of the long proportion, which leads to outperforming the benchmark. However, when comparing with the long-only strategy, this negative contribution still cannot be managed

to overcome through the benefit of a long position on higher ESG ranking stocks. The reason behind this loss is due to the outperformance of those poorly ranked, especially shunned, stocks in the short position. This finding confirmed the argument of Statman and Glushkov (2009). Some financial behavior theory can further explain this phenomenon, as mentioned in the literature review (Derwall, Koedijk, and Ter Horsk 2011; Hong and Kacperczyk 2009; Merton 1987; Heinkel, Kraus, and Zechner 2001).

This thesis provides a new perspective of the integration of an active extension strategy on the latest ESG literature. The active trading strategy for ESG investment was applied to negative screening and each individual dimension screening, by testing and decomposing the performance of returns, and risk measurement. The present results are significant in at least two major respects, the size bias control, and the statistic test for returns comparison between an active extension strategy, and a long-only strategy, which provide a more reliable outcome. Nevertheless, the scope of this study was constrained as it was tilted towards the industry bias, due to the selection of stocks by ESG ranking, which has been mentioned above. Another limitation is the lack of incorporation of the costs associated with the implementation of this trading strategy. This cost cannot be ignored, and generally includes transaction costs, short sales cost, management fee and additional performance fee (Sorensen, Hua, and Qian 2007). The level of cost varies according to the funds capitalization, the ability of the active manager, and variety among companies in the financial industry.

7. Conclusion

This study set out to find abnormal returns through the implementation of an active extension trading strategy by incorporating an ESG element. The results of this analysis provide strong evidence that the 130/30 strategy is a feasible strategy that outperforms the benchmark, producing higher abnormal returns of up to 8.532 percent per year (130/30 top 90% and bottom-shunned portfolio). These findings suggest that eliminating the long-only constraint in stocks

with better ESG performance may diversify a portfolio, and increase its performance in the long portion, and somehow bear the loss from short positions due to the outperformance of those poorly score ranked stocks and shunned stocks (relative to the benchmark). Consequently, it leads to generate a significant positive active return. In the case of the individual social and governance screening rankings, in both screenings, low score rated portfolios produced higher returns than the benchmark and the top portfolios, leading the 130/30 portfolios to be underperformed compared to the long top-only portfolio. In the study of information ratio, and the overall alpha-generation analysis, the 130/30 strategy, cannot add meaningful value over the conventional long-only strategy. This consequence is primarily due to the insignificant boost in alpha. As the result, the gain of the 130/30 strategy is essentially offset by the negative performance contribution of the short position. Nevertheless, it is still possible slightly improve the information ratio when changing the long-short exposure and cut-offs.

The insights obtained from this study may provide assistance to fund managers and ESG investment concerned investors. The results suggested that a further study could explore how to boost the efficiency of the short position on poor ESG performance companies to enable 130/30 strategy to greatly outperform by the long-only strategy, which is the main question posed in this study. With this in mind, a combination of the other ESG investment approaches, and the active extension technique, rather than the screening method, would contribute to a greater performance outcome here. In addition, the study recommends that developing an optimal active extension portfolio, and risk management, should be carried out by high overall ESG rating companies, and can be further investigated.

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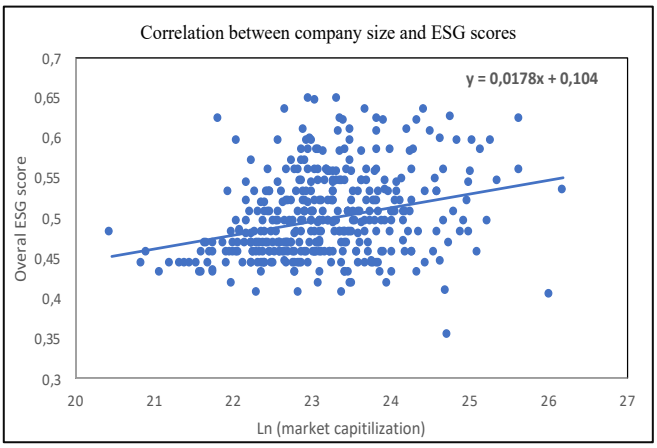
Appendix

Table 1. Data

ESG bias - size bias and sector bias

Table 1.1. The correlations between the firm size and score



Correlation for overal ESG score and individual E, S and G

	Observations	Slope	R2
ESG	453	0.0178***	0.0864
E	453	0.0393***	0.1011
S	453	0.0214***	0.0516
G	453	-0.0076**	0.0153

The scatterplot shows the ESG Score and market capitalization pairs, as well as the line of best fit. The data was set in 2016, as it has full data to run the regression.

Table 1.2. Classified industry firms based on the industry classification benchmark

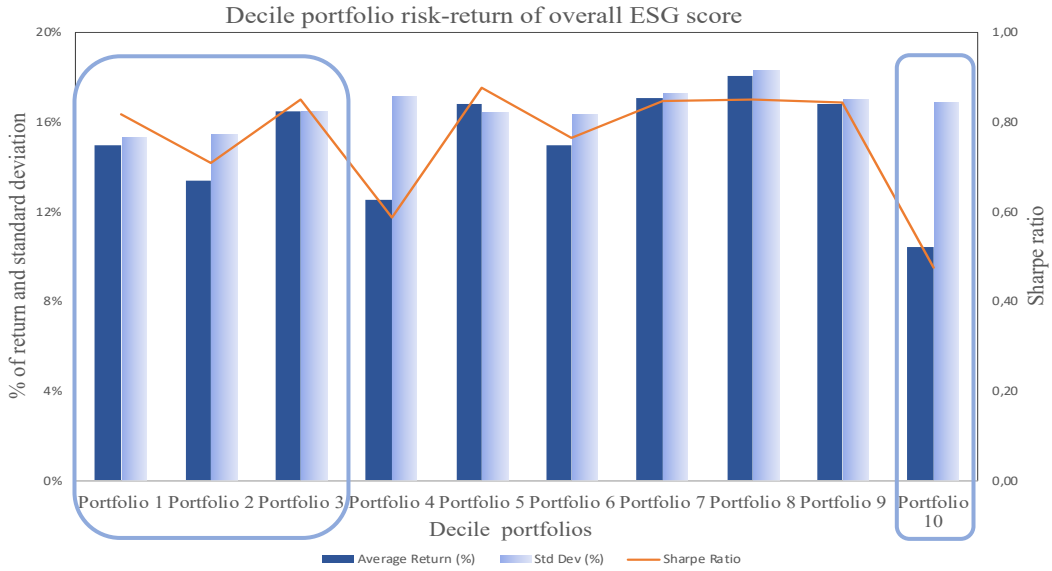
	Number of firms			Score across 26 years					
				ESG					
	1991-2000	2001-2010	2011-2016	Mean	Max	Min	E	S	G
Communication	3	12	17	0.457	0.685	0.165	0.485	0.482	0.404
C. Discretionary	15	35	40	0.461	0.769	0.125	0.487	0.468	0.428
C. Staples	15	21	20	0.471	0.722	0.215	0.506	0.507	0.400
Energy	4	15	21	0.430	0.697	0.178	0.404	0.448	0.438
Financials	18	45	54	0.470	0.660	0.154	0.477	0.518	0.415
Health Care	14	47	57	0.464	0.835	0.164	0.486	0.488	0.419
Industrials	14	36	41	0.448	0.759	0.125	0.471	0.459	0.415
Materials	10	18	17	0.448	0.698	0.189	0.446	0.470	0.428
Real Estate	1	23	27	0.470	0.671	0.151	0.481	0.456	0.472
Technology	7	40	54	0.493	0.846	0.164	0.521	0.532	0.426
Utilities	0	5	9	0.448	0.712	0.202	0.410	0.484	0.449

*C.Discretionary denotes consumer discretionary

*C.Staples denotes consumer staples industry

Table 2. Portfolio formulation

Table 2.1. Non-controversial overall ESG score sample deciles portfolio risk-return



Average yearly return and standard deviation. Sharpe ratio is calculated by dividing excess return by its risk.

Table 2.2. Top-bottom sample deciles portfolio risk-return

		Table 2.2A: Decile portfolio risk-return					Table 2.2B: Cross-sectional correlations		
		Firms	N	Return	SD	SR	E	S	G
Overal ESG									
	Top	269	20580	14.600%	14.700%	0.831			
	Bottom	201	6996	10.500%	16.900%	0.474			
	Controversial	132	16044	12.400%	14.800%	0.663			
Individual dimension									
E	Top	443	70764	14.900%	15.100%	0.827	1	0.206	0.238
	Bottom	355	20256	12.800%	15.300%	0.672			
S	Top	461	74988	14.800%	14.900%	0.825	0.206	1	0.082
	Bottom	299	13764	15.800%	16.500%	0.811			
G	Top	463	77052	13.300%	15.200%	0.710	0.238	0.082	1
	Bottom	282	13968	14.000%	16.400%	0.704			

N denotes the observations of the sample portfolio, and return is the compounded annual return. Table 2.2A shows the risk-return for each sample portfolio. Table 2.2B shows the correlation between 3 dimensions of ESG score.

Table 2.3. MSCI ESG scores distribution by industry

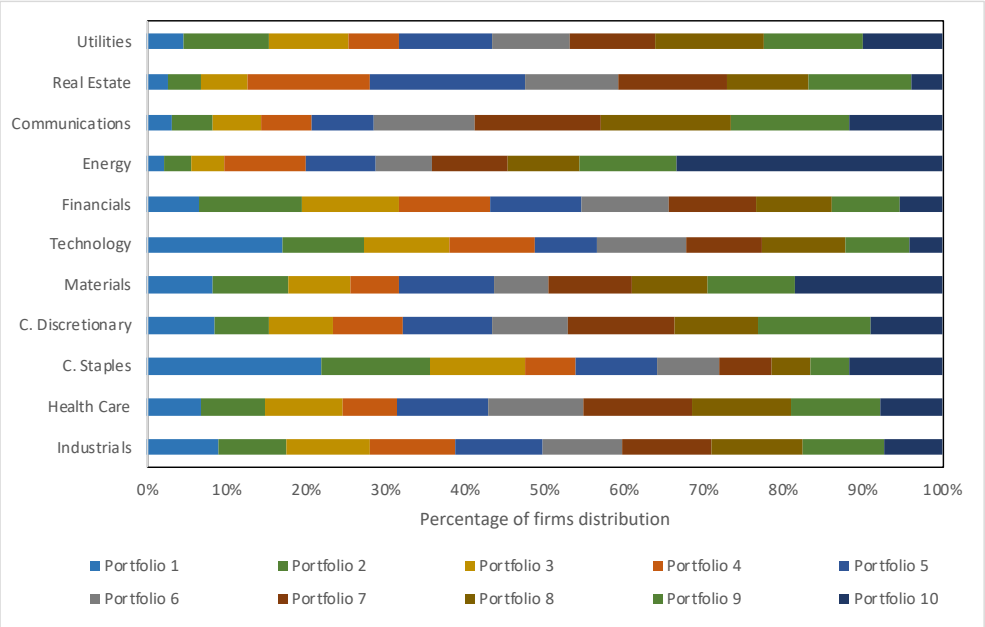


Table 3. Strategy portfolio performance

	Table 3A: Return				Table 3B: Risk-return					
	Return	t-dif	Relative return	t-dif	SR	TR	Skew	Kurt	JB	ASR
Benchmark	7.407%***				0.118	0.005	-0.692	1.578	57.321	0.116
Long only										
Long top-only	14.44%***	-	7.033%***	-	0.240	0.011	-0.389	2.084	64.291	0.235
130/30										
130/30 TB	15.782%***	-	8.375%***	-	0.255	0.012	-0.237	1.854	47.59	0.251
130/30 TS	15.096%***	-	7.689%***	-	0.242	0.011	-0.322	1.643	40.474	0.238
130/30 TBS	15.161%***	-	7.754%***	-	0.244	0.011	-0.303	1.723	43.365	0.240

The t-dif is the t test for the difference between the 130/30 portfolio and the long-top only portfolio.
a, b, and c indicate the statistical difference at the 10%, 5%, and 1% levels, respectively.

"-" indicates no statistically significant difference.

* , **, and **** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 4. Performance contribution

Portfolio of 130/30, top-bottom-shunned, (130/30 TBS)

	Long-Only	130/30 TBS	Long C	Short C	Interaction
1992	19.375%	23.272%	25.187%	-1.97%	0.056%
1993	15.821%	19.894%	20.567%	-0.848%	0.176%
1994	0.677%	0.537%	0.88%	-0.298%	-0.045%
1995	0.056%	0.543%	0.073%	0.508%	-0.038%
1996	-0.438%	0.005%	-0.569%	0.61%	-0.035%
1997	8.245%	14.347%	10.718%	3.168%	0.461%
1998	-3.853%	1.415%	-5.009%	6.159%	0.265%
1999	-5.903%	-0.774%	-7.673%	6.690%	0.209%
2000	21.91%	19.293%	28.483%	-8.968%	-0.222%
2001	18.824%	19.731%	24.472%	-4.647%	-0.094%
2002	11.44%	10.608%	14.872%	-4.181%	-0.083%
2003	8.511%	10.067%	11.065%	-0.939%	-0.059%
2004	15.368%	15.983%	19.979%	-3.97%	-0.026%
2005	8.248%	7.911%	10.722%	-2.684%	-0.128%
2006	1.236%	-1.15%	1.607%	-2.789%	0.031%
2007	0.791%	-3.36%	1.029%	-4.701%	0.313%
2008	8.172%	11.515%	10.623%	0.781%	0.11%
2009	19.245%	19.649%	25.018%	-5.1%	-0.269%
2010	6.021%	4.559%	7.827%	-3.275%	0.006%
2011	-0.895%	-2.537%	-1.164%	-1.413%	0.039%
2012	6.825%	7.804%	8.872%	-1.071%	0.003%
2013	2.430%	2.858%	3.159%	-0.291%	-0.01%
2014	3.964%	4.041%	5.153%	-1.092%	-0.021%
2015	0.868%	0.889%	1.128%	-0.221%	-0.017%
2016	6.018%	6.647%	7.824%	-1.156%	-0.021%
2017	3.053%	2.999%	3.969%	-0.948%	-0.022%
Annual	**7.033%**	**7.754%**	**9.142%**	**-1.293%**	**-0.095%**
# years of positive contribution	22	22	22	6	
# years outperform		17			
# years underperform		9			

Long C indicates the performance contribution of long portion and the short C indicates the performance contribution of short portion. The difference between active contribution of 130/30 TBS are the difference from Long C and Short C (for exemple-0.095%) defined as "Interaction", which is caused by the periodic rebalancing between long and short portfolios. # years of outperformance indicate the number of years that 130/30 TBS portfolio outperformed the long-only portfolio. The same pattern is applied on the # years underperform.

Table 5. Performance contribution of long top-only portfolio VS 130/30 TBS portfolio

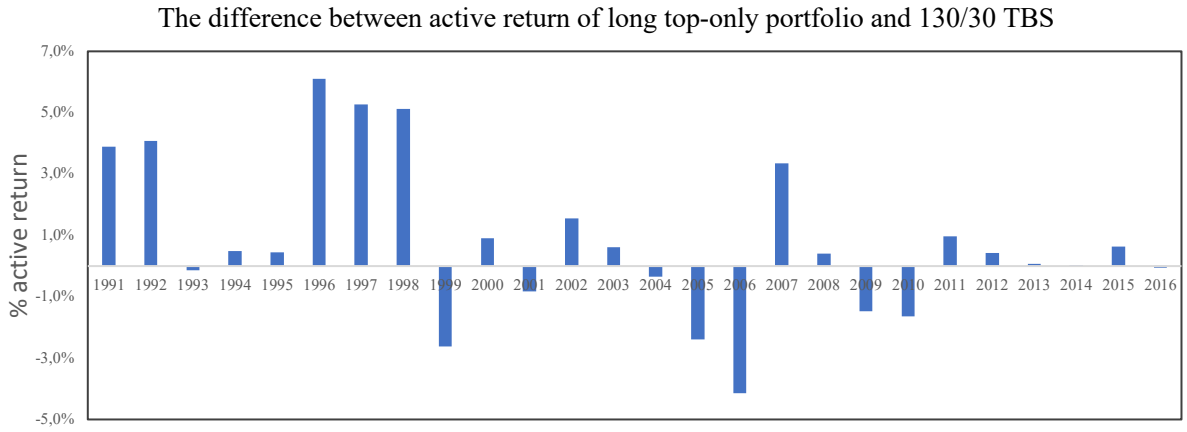


Table 6. Multi-factor analysis

	Alpha yearly	Alpha monthly	Mkt	SMB	HML	Momentum	R2
Panel A: 3 factor							
Long only	5.30%	0.004***	0.976***	0.093***	0.317***		0.874
130/ 30							
130/30 TB	6.50%	0.005***	0.97***	0.121***	0.336***		0.809
130/30 TS	5.90%	0.005***	0.995***	0.109***	0.289***		0.827
130/30 TBS	6,00%	0.005***	0.99***	0.111***	0.301***		0.792
Panel B: 4 factor							
Long only	5.80%	0.005***	0.953***	0.096***	0.300***	-0.001***	0.877
130/ 30							
130/30 TB	6.80%	0.006***	0.952***	0.124***	0.322***	0.000*	0.810
130/30 TS	6.30%	0.005***	0.979***	0.111***	0.276***	0.000*	0.829
130/30 TBS	6.30%	0.005***	0.973***	0.114***	0.288***	0.000*	0.828

*, **, and **** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

The data of 3 factor and 4 factor models was retrieved from Kenneth French´s website and employed one-month US treasury bills as a proxy for the risk-free rate.

Table 7. Robustness test

		Relative return	t-dif	IR	Jensen´s alpha	t-dif	Short C.
Table 7A: 30% and 90% top cut-off of overall ESG							
30% top cut-offs							
	Long only	7.033%***	-	0.305	0.561%***	-	
	130/30 TBS	7.754%***	-	0.296	0.613%***	-	-1.293%
90% top cut-offs							
	Long only	8.069%***	-	0.395	0.637%***	-	
	130/30 TBS	9.121%***	-	0.401	0.711%***	-	-1.293%
Table 7B: Individual dimension E. S and G							
E	Long-only	7.275%***	-	0.348	0.562%***	-	
	130/30	7.883%***	-	0.335	0.600%***	-	-2.187%
S	Long-only	7.147%***	-	0.353	0.554%***	-	
	130/30	6.749%***	-	0.319	0.531%***	-	-1.615%
G	Long-only	5.383%***	-	0.210	0.440%***	-	
	130/30	5.089%***	-	0.170	0.436%***	-	-1.615%

Relative return is the annualized compounded return. Information ratios are the arithimetic mean relative return divided by tracking error. Jensen´s alpha is on a monthly basis. Short C indicates the performance contribution of the short portion. The t-dif is the t-test for the difference between the 130/30 portfolio and the long-top only portfolio. "-" indicates no statistically significant difference. * , **, and **** indicate statistical significance at the 10%, 5% and 1% levels, respectively.